PROGRAM ABH:
THE MODIFIED ABH METHOD OF CELL
HOMOGENIZATION FOR TEMPEST

D. R. Skeen

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AEC RESEARCH &
DEVELOPMENT REPORT

Project	Task	Subtask
Hydramic Surfactant		60009
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HOMOGENIZATION FOR TEMPEST

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SECTION I: INTRODUCTION

The disadvantage factor theory, as originally presented by A. Amouyal, P. Benoist and J. Horowitz,^(1,2) has been programmed, with some modifications, in FORTRAN IV for the Univac 1107-8 computer. The program is intended to be used in conjunction with program TEMPEST⁽³⁾ to produce cell cross sections for use in broad-group constants codes.

The modifications to the Amouyal, Benoist and Horowitz theory are principally those described by Strawbridge,⁽⁴⁾ which allow for the use of cladding, instead of a void region, surrounding the fuel. In addition, a minor correction was introduced by the author and A. G. Gibbs which improves the treatment of the current relationships at the fuel and clad boundaries (Section II A). The entire theory with its modifications is described in Section II.

Input for program ABH, which is described in Section III, is via NAMELIST.⁽⁵⁾ Basically this code takes a set of cross sections from an existing TEMPEST library tape and calculates, for each TEMPEST energy, a set of disadvantage factors for a three region (fuel-clad-moderator) cell. The cross sections are then multiplied by these factors and a new TEMPEST library tape is written. Having thus smeared the cell spatially, the energy averaging may then be done by running a smeared cell case with program TEMPEST. Although the major portion of the program is new, mention should be made of the TEAM-AMBER^(6,7) code from which certain sections of logic were lifted.

SECTION II: THEORY OF THE MODIFIED ABH METHOD

Figure 1 The Modified ABH Cell

Assume the following nomenclature,

F_i = The volume fraction in the i^{th} region of the cell, whose volume is V_i . Radii and region numbers are shown in Figure 1,

ϕ_i = The average flux in the i^{th} region of the cell which contains a void instead of cladding,

$\hat{\phi}_i$ = The average flux, corrected for cladding, in the i^{th} region of the cell,

and

$\langle \phi \rangle$ = The average flux in the whole cell.

The following equations are used to calculate disadvantage factors by the modified ABH method.

$$\frac{\phi_1}{\phi_0} = \frac{a^2 A}{(b^2 - c^2)} \frac{\Sigma_{c_0}}{\Sigma_{c_1}} - \frac{2a^2}{c} \Sigma_{c_0} + \frac{a}{c} \frac{1}{(1-B)P}$$

where

$$A = 3 \Sigma_{tr_1} \Sigma_{c_1} b^2 \hat{C} + \frac{3}{2} \frac{V_1}{c} \Sigma_{c_1} \lambda$$

and $B = \frac{2\sqrt{2}}{\pi} \frac{c-a}{c}$

λ is tabulated as a function of Σ_{t_1} and $\hat{C}$ is calculated as

$$\hat{C} = \frac{1}{2} \left[\ln \left(\frac{b}{c} \right) \frac{b^2}{b^2 - c^2} - \frac{3}{4} + \frac{1}{4} \frac{c^2}{b^2} \right]$$

$$\frac{\hat{\phi}_1}{\phi_0} = \frac{\phi_1}{\phi_0} + a(c-a) \Sigma_{c_0} \left[\frac{3}{2} \Sigma_{tr_2} - \frac{1}{c} \right] + \frac{1}{2P} \left[\frac{(c-a)}{c} - \frac{2P}{1-B} \right]$$

$$\frac{\hat{\phi}_2}{\phi_0} = \frac{1}{P} - a \Sigma_{c_0} + \frac{3}{4} (c-a) a \Sigma_{tr_2} \Sigma_{c_0}$$

$$\frac{\langle \phi \rangle}{\phi_0} = F_0 + F_2 \frac{\hat{\phi}_2}{\phi_0} + F_1 \frac{\hat{\phi}_1}{\phi_0}$$

$$\frac{\hat{\phi}_2}{\langle \phi \rangle} = \frac{\hat{\phi}_2}{\phi_0} \cdot \frac{\phi_0}{\langle \phi \rangle}$$

$$\frac{\hat{\phi}_1}{\langle \phi \rangle} = \frac{\hat{\phi}_1}{\phi_0} \cdot \frac{\phi_0}{\langle \phi \rangle}$$

where P can be calculated by a method suggested by Amouyl, Benoist, and Horowitz⁽¹⁾

$$P = \frac{1}{1 + \frac{\Sigma_{c0}}{\Sigma_{T0}} \left[\chi \left(1 + \alpha \frac{\Sigma_{s0}}{\Sigma_{T0}} + \beta \frac{\Sigma_{s0}^2}{\Sigma_{T0}^2} \right) + a \Sigma_{T0} \right]}$$

where χ , α , and β are tabulated as functions of Σ_{t0} .

SECTION III: INPUT DESCRIPTION FOR PROGRAM ABH

All input to this program is via NAMELIST.⁽⁵⁾ The following is a description of the variables which may be input via NAMELIST. One note of warning, be sure to have a TEMPEST library tape listing handy when preparing input for Program ABH.

A. \$ Input

<u>Variable</u>	<u>Definition</u>
ISO (I,J,K)	Isotope ident numbers from the TEMPEST library tape to be used in the ABH calculation and whose values will be subsequently modified for the new TEMPEST tape.
DEN(I,J,K)	Isotope region densities to correspond to the isotope numbers given above.
RAD(K)	Region radii in cm.
NUM(K)	The number of isotopes in each region.
OUT	Output control (INTEGER); OUT = 0, short, OUT = 2, will list new tape and the disadvantage factors.

The above indices are defined as:

<u>Index</u>	<u>Definition</u>
I	The index of the cross section in this region (maximum of 50).
J	Normal TEMPEST Ident. Multiplier
1	0
2	100
3	200
4	300
K	ABH region radii in cm.
1	Fuel radius
2	Cladding outer radius
3	Moderator outer radius

<u>TEMPEST</u>	<u>ABH</u>
RS(5)	Cross Section Usage
--	Absorption
v	Fission
1-μ	Scatter
ξ	Scatter

Absorption
--
 $(1-\mu)\sigma_s$
 σ_s (only)

Note that this section of input is set up so that each cross section ident can be input. Thus, for the same material, one can use different scattering and absorption cross sections (not just those which differ by 100 multiples). This was necessitated by the fact that the present TEMPEST library will, for some isotopes, store 1.0 for ξ (in the RS(5) position) and then store $\xi\sigma_s(E)$ for $\sigma_s(E)$ making it impossible for ABH to pick up the proper scatter cross section. Normally, however, the only number that need be input is the base library ident. [$1 \leq \text{ISO}(I,J,K) \leq 99$] and multiples of 100 will be assumed for the other cross sections.

Following the make up of the cell disadvantage factors there is one final stage of input so that any final shifting can be done prior to output on the new tape.

B. \$ EDIT

<u>Variable</u>	<u>Definition</u>
ISO(I,J,K)	For input of cross section idents to change the cross sections being output on the new TEMPEST tape.
RSLAST(I,J,K)	Anything entered here will be placed in the last position of the RS vector before being output on the new TEMPEST library tape.

A description of the TEMPEST library tape will help describe the RSLAST input. The TEMPEST library tape format is as follows:

NAME	IDENT NO.	NO. RT VALUES			
R					
$\sqrt{E} \sigma_{2200}$	2	3	4	5	
RS					
1	2	3	4	RS(5)	
RT					
Tabulated cross sections if No. RT values $\neq 0$. Not present if No. Rt. Values = 0.					

For a discussion of those parameters see program TEMPEST⁽³⁾

Figure 3. TEMPEST LIBRARY FORMAT

For cross section idents of 100 through 300 the RS(5) is used for storage as shown under \$INPUT. It is this RS(5) position which is loaded when the new library tape is written. For example, in the test case, it became necessary to use the 431 hydrogen scattering cross section. However this isotope does not have ξ stored in RS(5) so that $\xi\sigma_s(E)$ could not be properly supplied for TEMPEST. Therefore ξ was input in the test case as shown in Appendix A.

SECTION IV

ABH PROGRAM LISTING

[illegible]

```
X30X
962H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
162H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
262H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
362H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
462H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
562H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY )
913 FORMAT(30X
662H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
762H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
862H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
962H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
162H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
233X23H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
233X23H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
462H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
X30X
562H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
633X59H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY /
733X59H MMYMMYMMYMMYMMYCCCCCFFFFFFFFFFFFFFFFFFFCCCCCMMYMMYMMYMMY )
914 FORMAT(39H10UNRECOVERABLE PROGRAM/PROGRAMMER ERROR)
915 FORMAT(1H05BX10END OF RUN)
916 FORMAT(1H0)
DATA(E(I),I=1,121)/
X .000, .001, .002, .003, .004, .005, .006, .007, .008, .009, .010,
X .011, .012, .013, .014, .015, .016, .017, .018, .019, .020, .021,
X .022, .023, .024, .025, .026, .027, .028, .029, .030, .031, .032,
X .033, .034, .035, .036, .037, .038, .039, .040, .041, .042, .043,
X .044, .045, .046, .047, .048, .049, .050, .051, .052, .053, .054,
X .055, .056, .057, .058, .059, .060, .061, .062, .063, .064, .065,
X .066, .067, .068, .069, .070, .071, .072, .073, .074, .075,
X .076, .077, .078, .079, .080, .081, .082, .083, .084, .085, .086,
X .087, .088, .089, .090, .091, .092, .093, .094, .095, .096, .097,
X .098, .099, .100, .101, .102, .103, .104, .105, .106, .107, .108,
X .109, .110, .111, .112, .113, .114, .115, .116, .117, .118, .119,
X .120, .121, .122, .123, .124, .125, .126, .127, .128, .129, .130,
 
```


X1.118034E	00,1.172497E	00,1.120948E	00,1.171271E	00,1.173762E	00,	74
X1.140175E	00,1.104592E	00,1.145911E	00,1.172295E	00,1.177596E	00,	75
X1.161895E	00,1.166194E	00,1.171475E	00,1.174794E	00,1.179993E	00,	76
X1.183216E	00,1.187494E	00,1.187694E	00,1.190994E	00,1.200094E	00,	77
X1.204159E	00,1.200095E	00,1.212495E	00,1.216194E	00,1.220697E	00,	78
X1.224745E	00,1.220021E	00,1.232695E	00,1.236997E	00,1.240067E	00,	79
DATA(SRE(I),I=201,246)/						
X1.244990E	00,1.249000E	00,1.252991E	00,1.256991E	00,1.260992E	00,	80
X1.264911E	00,1.266958E	00,1.272792E	00,1.276715E	00,1.280829E	00,	81
X1.284523E	00,1.288410E	00,1.292285E	00,1.296148E	00,1.300000E	00,	82
X1.303840E	00,1.307670E	00,1.311486E	00,1.315295E	00,1.319091E	00,	83
X1.322876E	00,1.326650E	00,1.330413E	00,1.334166E	00,1.337909E	00,	84
X1.341641E	00,1.345362E	00,1.349074E	00,1.352775E	00,1.356466E	00,	85
X1.360147E	00,1.363818E	00,1.367479E	00,1.371131E	00,1.374773E	00,	86
X1.378405E	00,1.382027E	00,1.385641E	00,1.389244E	00,1.392839E	00,	87
X1.396424E	00,1.400000E	00,1.403567E	00,1.407125E	00,1.410674E	00,	88
X1.414214E	00,					

INTEGER ELEM,CROFIT,CUT,FOLL,BLANK

DATA LAST/8HX-LAST/,(NAME(I),I=1,5)/18HFUEL CCLAL GROD. 3/

DATA BLANK/1H /,CUT/2/,I/C/,KF/C/,(ROOT(I),ASOCT(I),I=1,5)/10*0./

NAMELIST/INPUT/ISO,DEN,RAD,NOH,CUT

NAMELIST/EDIT/ISO,RGLAST

CALL SETEOF(51)

CALL ADATE(MD)

CALL ATIME(MD(3))

WRITE(6,911)

WRITE(6,912)

WRITE(6,913) MD

CALL LINES(-999,55.)

C READ THE TEMPEST LIBRARY

20 I=I+1

IF(I.GT.200) GO TO 998

CALL KELLEY(ELEM(I),ID(I),NO(I),R(1,I),RS(1,I))

IF(LAST.EQ.ELFK(I)) GO TO 200

IF(NO(I).EQ.0) GO TO 50

KS=KF+1

IDKS(I) = KS-1

KF=KF+NO(I)

IF(KF.GT.9999) GO TO 998

CALL KELLIE(RT,KS,KF)

GO TO 50

200 IDMAX=I-1

REWIND 7

C SET UP CROSS SECTIONS AND CALCULATE C FACTORS

210 READ(5,INPUT)

CALL PRECON


```

        ICOL=-3
        CHOPIT=246
        DO 300 I=1,3
        DO 300 J=1,4
        DO 300 K=1,246
300  SIG(I,J,K)=0.
        CALL LINES(8,$301)
301  WRITE(6,901)
        DO 360 K=1,3
        L=NUM(K)
        GO TO 305
304  CALL LINES(6,$360)
        WRITE(6,901)
305  CALL LINES(2,$304)
        WRITE(6,903) K, IATE(K),RAD(K)
        DO 350 I=1,L
        ICOL=ICOL+3
        DO 340 J=1,4
        IF(J.EQ.1) GO TO 310
        IF(ISO(I,J,K).EQ.0) GO TO 306
        IF(ISO(I,J,K).NE.0.AND.DEN(I,J,K).EQ.0.) GO TO 307
        GO TO 310
306  ISO(I,J,K) = ISO(I,1,K) + (J-1)*100
307  DEN(I,J,K) = DEN(I,1,K)
310  CONTINUE
        IF(J.EQ.2) GO TO 340
        JJ=J
        IF(J.GT.2) JJ=J-1
C          LOCATE PROPER TEMPEST CROSS SECTION
        DO 313 M=1,IDMAX
        M=M
        IF(ISO(I,J,K)-ID(M)) 314,320,313
313  CONTINUE
314  HOLL(ICOL+JJ) = BLANK
        INT(ICOL+JJ) = 0
        LOT(ICOL+JJ) = 0.
        SMR(ICOL+JJ) = 0.
        GO TO 340
C          CALCULATE CELL CROSS SECTIONS
320  IF(RO(M).GT.0) CHOPIT=MIN0(CHOPIT,RO(M))
        JJJ = ID(M)/100 + 1
        DO 330 N=1,CHOPIT
        IDENT = 10KS(M)+N
        GO TO (1320,1320,2020,2020,1320,1320,1320,1320,1320,1320),JJJ
1320  FACTR=1./SRE(N)
        GO TO 321
2320  FACTR=1.
321  GO TO (322,324,326),JJ

```

```

C          ABSORPTION
322 IF(NO(M).EQ.0) GO TO 323
   SIG(K,1,N)=SIG(K,1,N)+PT(IDENT)*FACTR*DEF(I,J,K)
   SIG(K,3,N)=SIG(K,3,N)+PT(IDENT)*FACTR*DEF(I,J,K)
   SIG(K,4,N)=SIG(K,4,N)+PT(IDENT)*FACTR*DEF(I,J,K)
   GO TO 330
323 SIG(K,1,N)=SIG(K,1,N)+R(1,N)*FACTR*DEF(I,J,K)
   SIG(K,3,N)=SIG(K,3,N)+R(1,N)*FACTR*DEF(I,J,K)
   SIG(K,4,N)=SIG(K,4,N)+R(1,N)*FACTR*DEF(I,J,K)
   GO TO 330
C          TRANSPORT
324 IF(NO(M).EQ.0) GO TO 325
   SIG(K,4,N)=SIG(K,4,N)+RT(IDENT)*RS(5,M)*FACTR*DEF(I,J,K)
   GO TO 330
325 SIG(K,4,N)=SIG(K,4,N)+R(1,M)*RS(5,M)*FACTR*DEF(I,J,K)
   GO TO 330
C          SCATTERING
326 IF(NO(M).EQ.0) GO TO 327
   SIG(K,2,N)=SIG(K,2,N)+RT(IDENT)*FACTR*DEN(I,J,K)
   SIG(K,3,N)=SIG(K,3,N)+RT(IDENT)*FACTR*DEN(I,J,K)
   GO TO 330
327 SIG(K,2,N)=SIG(K,2,N)+R(1,M)*FACTR*DEN(I,J,K)
   SIG(K,3,N)=SIG(K,3,N)+R(1,M)*FACTR*DEN(I,J,K)
330 CONTINUE
   HOLL(ICOL+JJ) = ELEN(M)
   INT(ICOL+JJ) = IF(1)
   BOT(ICOL+JJ) = DEN(I,J,K)
   SMR(ICOL+JJ) = DEF(I,J,K)*V(K)
340 CONTINUE
   IF(ICOL.NF.3) GO TO 350
   GO TO 346
345 CALL LINES(7,$350)
   WRITE(6,901)
   WRITE(6,903) K,NAME(K),RAD(K)
346 CALL LINES(4,$345)
   WRITE(6,902) (HOLL(N),INT(N),N=1,6),(BOT(N),N=1,6),(SMR(N),N=1,6)
   ICOL=-3
350 CONTINUE
   IF(ICOL.NF.4) GO TO 360
   GO TO 355
353 CALL LINES(7,$354)
354 WRITE(6,901)
   WRITE(6,903) K,NAME(K),RAD(K)
355 CALL LINES(4,$353)
   WRITE(6,902) (HOLL(N),INT(N),N=1,3),(BOT(N),N=1,3),(SMR(N),N=1,3)
360 ICOL=-3
C          CALCULATE S FACTORS
   L=490,N=2,CHOP1,

```

```

490 CALL ABCDR(SIG(1,1,N),SIG(2,1,N),SIG(3,1,N),SIG(1,2,N),SIG(2,2,N),
10 SIG(3,2,N),SIG(1,3,N),SIG(2,3,N),SIG(3,3,N),SIG(1,4,N),SIG(2,4,N),
20 SIG(3,4,N),G(N,1),G(N,2),G(N,3))
    G(1,1) = G(2,1)
    G(1,2) = G(2,2)
    G(1,3) = G(2,3)
    MSP = (CHOPIT+7)/8
    IF(OUT.NE.2) GO TO 1490
    DO 4490 K=1,3
    CALL LINES(MSP+4,$2490)
2490 WRITE(6,909) K
    DO 4490 J=1,4
    IF(J.NE.1) CALL LINES(MSP+2,$3490)
    WRITE(6,916)
3490 DO 4490 I=1,MSP
4490 WRITE(6,904) (N,SIG(K,J,N),N=1,CHOPIT,MSP)
1490 IF(OUT.LT.1) GO TO 500
C          OUT=1 *** INTERMEDIATE OUTPUT FORM
    DO 495 K=1,3
    CALL LINES(MSP+3,$491)
491 WRITE(6,905) NAME(K)
    DO 495 I=1,MSP
495 WRITE(6,904) (N,G(N,K),N=1,CHOPIT,MSP)

C          WRITE NEW TEMPEST TAPE
500 READ(5,EDIT)
    IF(OUT.NE.2) CALL LINES(-1,$501)
    GO TO 502
501 WRITE(6,907)
502 DO 600 J=1,4
    NEWID = 100*(J-1)
    DO 600 K=1,3
    L=NUM(K)
    DO 600 I=1,L
    NEWID = NEWID+1
    DO 510 M=1,IDMAX
    M=M
510 IF(ISO(1,J,K).EQ.ID(M)) GO TO 515
    GO TO 600
515 JJJ = ID(M)/100 + 1
    DO 590 N=1,CHOPIT
    GO TO (520,520,520,530,520,520,520,520,520),JJJ
520 FACTR = 1./SRE(N)
    GO TO 54
530 FACTR = 1.
540 GO TO (55,56,565,730,530,550,550,570,570,550),J
550 FACTR = FACTR*SRE(N)

```

```

555 IDENT = IDKS(M)+N
    IF(NO(M).EQ.0) GO TO 560
    XSECT(N) = RT(IDENT)*G(I,K)*FACR
    GO TO 590
560 XSECT(N) = R(1,M)*G(I,K)*FACR
590 CONTINUE
    ROOT(1) = XSECT(1)
    RSOUT(5) = RS(5,1)
    IF(RSLAST(I,J,K).NE.2) RSOUT(5)=RSLAST(I,J,K)
    CALL YELLEN(ELEM(N),NEWID,CHOPIT,ROOT,RSOUT)
    CALL FILLER(XSECT,1,CHOPIT)
    IF(OUT.EQ.2) CALL LINES(RSP+7,8704)
    IF(OUT.EQ.2) WRITE(6,907)
    GO TO 595
594 WRITE(6,907)
    CALL LINES(1,8394)
C      OUT = 2 *** LIST TEMPEST TAPL
595 WRITE(6,908) ELEM(N),NEWID,IS(N),K,F,CHOPIT
    IF(OUT.EQ.2) WRITE(6,910) (ROOT(II),II=1,5),(RSOUT(II),II=1,5),
    1(II,XSECT(II),II=1,CHOPIT)
600 CONTINUE
601 I=0
    NEWID = 900
    RSOUT(5) = 0.
    DO 700 K=1,3
    DO 650 N=2,CHOPIT
650 G(N,K) = G(N,K)*SRE(N)
    G(1,K) = G(2,K)
    NEWID = NEWID+1
    ROOT(1) = G(1,K)
    CALL YELLEN(NAMF(K),NEWID,CHOPIT,ROOT,RSOUT)
    CALL FILLER(G(1,K),1,CHOPIT)
    IF(OUT.NE.2) GO TO 705
    CALL LINES(RSP+7,8704)
704 WRITE(6,907)
705 IF(OUT.NE.2) CALL LINES(1,8704)
    WRITE(6,908) NAMF(K),NEWID,1,K,1,CHOPIT
    IF(OUT.EQ.2) WRITE(6,910) (ROOT(II),II=1,5),(RSOUT(II),II=1,5),
    1(II,G(II,K),II=1,CHOPIT)
700 CONTINUE
    ROOT(1) = 0.
    CALL YELLEN(LAST,NEWID,ROOT,RSOUT)
740 CALL LINES(3,8744)
744 WRITE(6,907)
    WRITE(6,908) LAST,(I,J=1,5)
    END FILE 8
    GO TO 21
998 WRITE(6,914)

```

```
GO TO 999  
1 WRITE(8) MD  
END FILE 8  
999 RETURN  
CALL EXIT  
END
```

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FOOTNOTES

901 FIVE-HILL DRIVE, NEW YORK, N.Y. 10025 TEL: 212-633-1515

, 1446;

1- (10) 1, 1, 1

7. *Environ. Sci. Technol.* 1990, 24, 1033-1037.

RECEIVED

LINE	DATE	TIME	LOCATION
1	10/10/10	10:00	10/10/10
2	10/10/10	10:00	10/10/10
3	10/10/10	10:00	10/10/10
4	10/10/10	10:00	10/10/10
5	10/10/10	10:00	10/10/10
6	10/10/10	10:00	10/10/10
7	10/10/10	10:00	10/10/10
8	10/10/10	10:00	10/10/10
9	10/10/10	10:00	10/10/10
10	10/10/10	10:00	10/10/10
11	10/10/10	10:00	10/10/10
12	10/10/10	10:00	10/10/10
13	10/10/10	10:00	10/10/10
14	10/10/10	10:00	10/10/10
15	10/10/10	10:00	10/10/10
16	10/10/10	10:00	10/10/10
17	10/10/10	10:00	10/10/10
18	10/10/10	10:00	10/10/10
19	10/10/10	10:00	10/10/10
20	10/10/10	10:00	10/10/10
21	10/10/10	10:00	10/10/10
22	10/10/10	10:00	10/10/10
23	10/10/10	10:00	10/10/10
24	10/10/10	10:00	10/10/10
25	10/10/10	10:00	10/10/10
26	10/10/10	10:00	10/10/10
27	10/10/10	10:00	10/10/10
28	10/10/10	10:00	10/10/10
29	10/10/10	10:00	10/10/10
30	10/10/10	10:00	10/10/10
31	10/10/10	10:00	10/10/10
32	10/10/10	10:00	10/10/10
33	10/10/10	10:00	10/10/10
34	10/10/10	10:00	10/10/10
35	10/10/10	10:00	10/10/10
36	10/10/10	10:00	10/10/10
37	10/10/10	10:00	10/10/10
38	10/10/10	10:00	10/10/10
39	10/10/10	10:00	10/10/10
40	10/10/10	10:00	10/10/10
41	10/10/10	10:00	10/10/10
42	10/10/10	10:00	10/10/10
43	10/10/10	10:00	10/10/10
44	10/10/10	10:00	10/10/10
45	10/10/10	10:00	10/10/10
46	10/10/10	10:00	10/10/10
47	10/10/10	10:00	10/10/10
48	10/10/10	10:00	10/10/10
49	10/10/10	10:00	10/10/10
50	10/10/10	10:00	10/10/10
51	10/10/10	10:00	10/10/10
52	10/10/10	10:00	10/10/10
53	10/10/10	10:00	10/10/10
54	10/10/10	10:00	10/10/10
55	10/10/10	10:00	10/10/10
56	10/10/10	10:00	10/10/10
57	10/10/10	10:00	10/10/10
58	10/10/10	10:00	10/10/10
59	10/10/10	10:00	10/10/10
60	10/10/10	10:00	10/10/10
61	10/10/10	10:00	10/10/10
62	10/10/10	10:00	10/10/10
63	10/10/10	10:00	10/10/10
64	10/10/10	10:00	10/10/10
65	10/10/10	10:00	10/10/10
66	10/10/10	10:00	10/10/10
67	10/10/10	10:00	10/10/10
68	10/10/10	10:00	10/10/10
69	10/10/10	10:00	10/10/10
70	10/10/10	10:00	10/10/10
71	10/10/10	10:00	10/10/10
72	10/10/10	10:00	10/10/10
73	10/10/10	10:00	10/10/10
74	10/10/10	10:00	10/10/10
75	10/10/10	10:00	10/10/10

GO TO 35

2. Life Insurance

1. *Form* (1) $\frac{1}{2}$ (2) $\frac{1}{4}$ (3) $\frac{1}{8}$ (4) $\frac{1}{16}$ (5) $\frac{1}{32}$ (6) $\frac{1}{64}$ (7) $\frac{1}{128}$ (8) $\frac{1}{256}$ (9) $\frac{1}{512}$ (10) $\frac{1}{1024}$ (11) $\frac{1}{2048}$ (12) $\frac{1}{4096}$ (13) $\frac{1}{8192}$ (14) $\frac{1}{16384}$ (15) $\frac{1}{32768}$ (16) $\frac{1}{65536}$ (17) $\frac{1}{131072}$ (18) $\frac{1}{262144}$ (19) $\frac{1}{524288}$ (20) $\frac{1}{1048576}$ (21) $\frac{1}{2097152}$ (22) $\frac{1}{4194304}$ (23) $\frac{1}{8388608}$ (24) $\frac{1}{16777216}$ (25) $\frac{1}{33554432}$ (26) $\frac{1}{67108864}$ (27) $\frac{1}{134217728}$ (28) $\frac{1}{268435456}$ (29) $\frac{1}{536870912}$ (30) $\frac{1}{1073741824}$ (31) $\frac{1}{2147483648}$ (32) $\frac{1}{4294967296}$ (33) $\frac{1}{8589934592}$ (34) $\frac{1}{17179869184}$ (35) $\frac{1}{34359738368}$ (36) $\frac{1}{68719476736}$ (37) $\frac{1}{137438953472}$ (38) $\frac{1}{274877906944}$ (39) $\frac{1}{549755813888}$ (40) $\frac{1}{1099511627776}$ (41) $\frac{1}{2199023255552}$ (42) $\frac{1}{4398046511104}$ (43) $\frac{1}{8796093022208}$ (44) $\frac{1}{17592186044416}$ (45) $\frac{1}{35184372088832}$ (46) $\frac{1}{70368744177664}$ (47) $\frac{1}{140737488355328}$ (48) $\frac{1}{281474976710656}$ (49) $\frac{1}{562949953421312}$ (50) $\frac{1}{1125899906842624}$ (51) $\frac{1}{2251799813685248}$ (52) $\frac{1}{4503599627370496}$ (53) $\frac{1}{9007199254740992}$ (54) $\frac{1}{18014398509481984}$ (55) $\frac{1}{36028797018963968}$ (56) $\frac{1}{72057594037927936}$ (57) $\frac{1}{144115188075855872}$ (58) $\frac{1}{288230376151711744}$ (59) $\frac{1}{576460752303423488}$ (60) $\frac{1}{1152921504606846976}$ (61) $\frac{1}{2305843009213693952}$ (62) $\frac{1}{4611686018427387904}$ (63) $\frac{1}{9223372036854775808}$ (64) $\frac{1}{18446744073709551616}$ (65) $\frac{1}{36893488147419103232}$ (66) $\frac{1}{73786976294838206464}$ (67) $\frac{1}{147573952589676412928}$ (68) $\frac{1}{295147905179352825856}$ (69) $\frac{1}{590295810358705651712}$ (70) $\frac{1}{1180591620717411303424}$ (71) $\frac{1}{2361183241434822606848}$ (72) $\frac{1}{4722366482869645213696}$ (73) $\frac{1}{9444732965739290427392}$ (74) $\frac{1}{18889465931478580854784}$ (75) $\frac{1}{37778931862957161709568}$ (76) $\frac{1}{75557863725914323419136}$ (77) $\frac{1}{151115727451828646838272}$ (78) $\frac{1}{302231454903657293676544}$ (79) $\frac{1}{604462909807314587353088}$ (80) $\frac{1}{1208925819614629174706176}$ (81) $\frac{1}{2417851639229258349412352}$ (82) $\frac{1}{4835703278458516698824704}$ (83) $\frac{1}{9671406556917033397649408}$ (84) $\frac{1}{19342813113834066795298816}$ (85) $\frac{1}{38685626227668133590597632}$ (86) $\frac{1}{77371252455336267181195264}$ (87) $\frac{1}{154742504910672534362390528}$ (88) $\frac{1}{309485009821345068724781056}$ (89) $\frac{1}{618970019642690137449562112}$ (90) $\frac{1}{1237940039285380274899124224}$ (91) $\frac{1}{2475880078570760549798248448}$ (92) $\frac{1}{4951760157141521099596496896}$ (93) $\frac{1}{9903520314283042199192993792}$ (94) $\frac{1}{19807040628566084398385987584}$ (95) $\frac{1}{39614081257132168796771975168}$ (96) $\frac{1}{79228162514264337593543950336}$ (97) $\frac{1}{158456325028528675187087900672}$ (98) $\frac{1}{316912650057057350374175801344}$ (99) $\frac{1}{633825300114114700748351602688}$ (100) $\frac{1}{1267650600228229401496703205376}$ (101) $\frac{1}{2535301200456458802993406410752}$ (102) $\frac{1}{5070602400912917605986812821504}$ (103) $\frac{1}{10141204801825835211973625643008}$ (104) $\frac{1}{20282409603651670423947251286016}$ (105) $\frac{1}{40564819207303340847894502572032}$ (106) $\frac{1}{81129638414606681695789005144064}$ (107) $\frac{1}{162259276829213363391578010288128}$ (108) $\frac{1}{324518553658426726783156020576256}$ (109) $\frac{1}{649037107316853453566312041152512}$ (110) $\frac{1}{1298074214633706907132624082305024}$ (111) $\frac{1}{2596148429267413814265248164610048}$ (112) $\frac{1}{5192296858534827628530496329220096}$ (113) $\frac{1}{10384593717069655257060992658440192}$ (114) $\frac{1}{20769187434139310514121985316880384}$ (115) $\frac{1}{41538374868278621028243970633760768}$ (116) $\frac{1}{83076749736557242056487941267521536}$ (117) $\frac{1}{166153499473114484112975882535043072}$ (118) $\frac{1}{332306998946228968225951765070086144}$ (119) $\frac{1}{664613997892457936451903530140172288}$ (120) $\frac{1}{1329227995784915872903807060280344576}$ (121) $\frac{1}{2658455991569831745807614120560689152}$ (122) $\frac{1}{5316911983139663491615228241121378304}$ (123) $\frac{1}{1063382396627932698323045648224$

90-11-1-2-6-1

25 JUL 1975

Time (min)	A (%)	B (%)	C (%)	D (%)	E (%)
0	0	0	0	0	0
10	85	5	5	10	10
20	0	10	10	20	20
30	0	15	15	30	30
40	0	20	20	40	40
50	0	25	25	50	50
60	0	30	30	60	60
70	0	35	35	70	70
80	0	40	40	80	80
90	0	45	45	90	90
100	0	50	50	100	100
110	0	55	55	100	100
120	0	60	60	100	100

[illegible]

100

025.05

1. *Chlorophyll a* and *Chlorophyll b* were determined by the method of Lichtenthaler and Whistler (1973). The total chlorophyll content was determined by the method of Arar and Cook (1980). The carotenoid content was determined by the method of Lichtenthaler and Whistler (1973). The total carotenoid content was determined by the method of Arar and Cook (1980). The total protein content was determined by the method of Lowry et al. (1951). The total lipid content was determined by the method of Folch et al. (1957). The total carbohydrate content was determined by the method of Dubois and Gilles (1950). The total nucleic acid content was determined by the method of Burton (1956). The total ash content was determined by the method of AOAC (1990). The total moisture content was determined by the method of AOAC (1990). The total dry matter content was determined by the method of AOAC (1990). The total organic acid content was determined by the method of AOAC (1990). The total alkaloid content was determined by the method of AOAC (1990). The total saponin content was determined by the method of AOAC (1990). The total tannin content was determined by the method of AOAC (1990). The total flavonoid content was determined by the method of AOAC (1990). The total phenolic content was determined by the method of AOAC (1990). The total terpenoid content was determined by the method of AOAC (1990). The total steroid content was determined by the method of AOAC (1990). The total glycoside content was determined by the method of AOAC (1990). The total alkaloid content was determined by the method of AOAC (1990). The total saponin content was determined by the method of AOAC (1990). The total tannin content was determined by the method of AOAC (1990). The total flavonoid content was determined by the method of AOAC (1990). The total phenolic content was determined by the method of AOAC (1990). The total terpenoid content was determined by the method of AOAC (1990). The total steroid content was determined by the method of AOAC (1990). The total glycoside content was determined by the method of AOAC (1990).

02605

```
SUBROUTINE EILLEX (RT,KS,KF)
  DIMENSION RT(2),A(22)
  KK = KS
  50 KKK=KINQ(KK+21,KF)
  DO 100 K=KK,KKK
  100 A(K-KK+1) = RT(K)
  IF(KKK-KF) 150,200,200
  150 WRITE (8)A
  KK=KKK+1
  GO TO 50
  200 KK=KF-KK+2
  IF (KK - 22) 210,210,250
  210 DO 225 K=KK,22
  225 A(K) = 0.
  WRITE (8)A
  250 IF (KK-1) 999,999,250
  260 KK=1
  GO TO 210
  999 RETURN
  END
```

```
SUBROUTINE YELLEK (E,I,N,R,RS)
DIMENSION A(22),R(2),RS(2)
A(1)=F
A(2)=I
A(3)=N
DO 100 K=1,5
A(K+3) = R(K)
100 A(K+8) = RS(K)
DO 150 K=14,22
150 A(K) =0.
WRITE (8)A
RETURN
END
```

4/5/86


```

SUBROUTINE KELLIE(RT,KS,KF)
DIMENSION RT(2),A(22)
KK=KS
50 KKK=MIN0(KK+21,KF)
  READ (7) A
  DO 100 K=KK,KKK
100 RT(K) = A(K-KK+1)
  KK=KKK+1
  IF(KKK-KF)50,150,150
150 READ (7) A
  RETURN
END

```

3/30/66

```
SUBROUTINE KELLEY(E,I,N,R,RS)
  DIMENSION A(22),R(2),RS(2)
  READ (7) A
  F=A(1)
  I=A(2)
  N=A(3)
  DO 100 K=1,5
    R(K) = A(K+3)
100 RS(K) = A(K+8)
  RETURN
  END
```

```

SUBROUTINE ABCDR(SIGAP,SIGAC,SIGAM,SIGSP,SIGSC,SIGSM,SIGTP,SIGTC,
1 SIGTM,SIGRP,SIGRC,SIGRM,GFUEL,GCLAD,GRCD)
C AMER PROGRAM FOR CDC 1604A COMPUTER BY R. FRIED
COMMON/AMER/RFUEL,RCLAD,RCELL,AFUEL,ACLAD,AMOD,VFUEL,VCLAD,VMOD,
1 T,P,C,OTHER(3),AXJ(24),ALPHJ(24),BETAJ(24),ALAMJ(24),X(24)
X1=RFUEL*SIGTP
POCD=RCLAD
DO 807 N=1,24
N=N+1
IF(X(N)-X1) 807,809,809
807 CONTINUE
809 DELX=X(N)-X(N-1)
DAXJ=AXJ(N)-AXJ(N-1)
SLOPA=DAXJ/DELX
AXI=SLOPA*(X1-X(N-1))+AXJ(N-1)
DALPJ=ALPHJ(N)-ALPHJ(N-1)
SLOPB=DALPJ/DELX
ALPHI=SLOPB*(X1-X(N-1))+ALPHJ(N-1)
DBETAJ=BETAJ(N)-BETAJ(N-1)
SLOPC=DBETAJ/DELX
BETAI=SLOPC*(X1-X(N-1))+BETAJ(N-1)
BAP=SIGAP/SIGTP
BSP=SIGSP/SIGTP
XTBC=POCD*SIGSM
DO 142 K=1,24
IF(X(K)-XTBC) 142,143,143
142 CONTINUE
143 DX2=X(K)-X(K-1)
DALAM=ALAMJ(K)-ALAMJ(K-1)
SLOPD=DALAM/DX2
ALAM=SLOPD*(XTBC-X(K-1))+ALAMJ(K-1)
P=1./((1.+BAP*(AXI*(1.+ALPHI*BSP+BETAI*BSP**2)+RFUEL*SIGTP))
A=C*RCELL**2*3.*SIGA*SIGRC+AFUEL*ALAM*SIGAP*1.5/RCLAD
FM=AFUEL/AMOD*A*SIGAP/SIGAM-2.*AFUEL/RCLAD*SIGAP+RFUEL/RCLAD/
1 P/(1.-B)+AFUEL*A*SIGAP*(1.5*SIGRC-1./RCLAD)+0.5/P*(1/RCLAD
2 -RFUEL/RCLAD*(1.+1)/(1.-1)+1.)
RCLAD=1./P+RFUEL*SIGAP+0.75*A*RFUEL*SIGRC*SIGAP
RFUEL=VFUEL+VCLAD*RCLAD+VMOD*P
GFUEL=1./RFUEL
GCLAD=GFUEL*SCLAD
GMOD=GFUEL*PM
RETURN
END

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SUBROUTINE PRECON

COMMON/AMBER/R(3),A(3),V(3),T,U,C,OTHER(3),
X AXJ(24),ALPHJ(24),BETAJ(24),ALAMJ(24),X(24)

DATA(AXJ(M),M=1,24)/

10.0	,0.06499	,0.1346	,0.2298	,0.3044	,0.4561,
20.5920	,0.7389	,0.8952	,1.0591	,1.2292	,1.4045,
31.5841	,1.7668	,1.9524	,2.1462	,2.3295	,2.5204,
42.7126	,2.9059	,3.0998	,3.2947	,3.4897	,3.6851/

DATA(ALPHJ(M),M=1,24)/

10.0	,0.014	,0.027	,0.039	,0.052	,0.064,
20.075	,0.086	,0.096	,0.105	,0.114	,0.121,
30.129	,0.136	,0.142	,0.148	,0.155	,0.161,
40.166	,0.170	,0.174	,0.178	,0.182	,0.186/

DATA(BETAJ(M),M=1,24)/

10.0	,0.008	,0.016	,0.021	,0.024	,0.026,
20.0274	,0.028	,0.0284	,0.0283	,0.0278	,0.027,
30.026	,0.025	,0.0242	,0.0235	,0.0228	,0.0223,
40.0218	,0.0214	,0.021	,0.0206	,0.0203	,0.020/

DATA(ALAMJ(M),M=1,24)/

11.333	,1.145	,1.066	,1.014	,0.972	,0.946,
20.910	,0.887	,0.869	,0.853	,0.840	,0.830,
30.820	,0.812	,0.803	,0.797	,0.791	,0.785,
40.780	,0.777	,0.775	,0.773	,0.774	,0.773/

DATA(X(M),M=1,24)/

10.0	,0.2	,0.4	,0.6	,0.8	,1.0 ,
21.2	,1.4	,1.6	,1.8	,2.0	,2.2 ,
32.4	,2.6	,2.8	,3.0	,3.2	,3.4 ,
43.6	,3.8	,4.0	,4.2	,4.4	,4.6 /

A(1) = P(1)**2

A(2) = R(2)**2 - R(1)**2

A(3) = R(3)**2 - R(2)**2

DO 10 I=1,3

10 V(I) = A(1)/R(3)**2

RA = R(2)/R(3)

RIA = 1./RA

PII = ALOG(RIA)

PI = 1./(1.-RA**2)

PVA = 1.-RA

C= 0.5* (PII* PI -0.75+(0.25* RA**RA))

T=R(2)-R(1)

B=0.9003166*SQRT(T/R(2))

RETURN

END

SECTION V

ABH AND TEMPEST SAMPLE CASES

 

ABM METHOD FOR TERREST

*** ABM TEST * 2.2 W/O PU02-U02 (8PC PU240) ROD IN H2O * .80 LS. ***

* 1 *

CROSS SECTION DEFINITION

NAME / NUMBER
DENSITY
SCALAR DENSITY

ABSORPTION	**	TRANSPORT	**	SCATTER	**	ABSORPTION	**	TRANSPORT	**	SCATTER

* * REGION 1 * *										
FUEL RADIUS = .64453 CM.										
U16 A / 2		U16 X / 202		OXYGEN / 302		U235 A / 18		U235 X / 218		U235 X / 218
4.23500-02		4.23500-02		4.23500-02		1.49490-04		1.49490-04		1.49490-04
1.54606-02		1.54606-02		1.54606-02		5.45612-05		5.45612-05		5.45612-05
U238 A / 20		U238 X / 220		U238 X / 220		PU239A / 31		PU239X / 231		PU239X / 231
2.06130-02		2.06130-02		2.06130-02		3.87890-04		3.87890-04		3.87890-04
7.52337-03		7.52337-03		7.52337-03		1.41573-04		1.41573-04		1.41573-04
PU240A / 22		PU240X / 222		PU240X / 222						
3.21500-05		3.21500-05		3.21500-05						
1.17342-05		1.17342-05		1.17342-05						
* * REGION 2 * *										
CLAD RADIUS = .72073 CM.										
ZR A / 3		ZR X / 203		ZR X / 203						
4.22600-02		4.22600-02		4.22600-02						
3.36265-03		3.36265-03		3.36265-03						
* * REGION 3 * *										
MOD. RADIUS = 1.05686 CM.										
U16 A / 2		U16 X / 202		OXYGEN / 302		H WA A / 30		H WA X / 230		H WA S / 431
3.34300-02		3.34300-02		3.34300-02		6.68600-02		6.68600-02		6.68600-02
1.81731-02		1.81731-02		1.81731-02		3.63462-02		3.63462-02		3.63462-02

ABR DETAIL FOR TEST

*** ABR TEST * 2.2 1/3 P02-J02 (APC P0240) ROD I H2O * .80 LS. ***

* 2 *

NEW TEST TAP

NAME	NEW ID.	OLD ID.	REGION	OLD TAP LOC.	NO. ENERGY POINTS
O16 A	1	1	1	3	116
U235 A	2	11	1	19	116
U238 A	3	20	1	21	116
P0239A	4	31	1	32	116
P0240A	5	42	1	23	116
Zr A	6	3	2	4	116
O16 A	7	2	3	3	116
H2A A	8	31	3	31	116
U235 F	102	116	1	77	116
P0239F	104	101	1	32	116
P0240F	105	100	1	79	116
O16 A	201	202	1	90	116
U235 A	202	210	1	105	116
U238 A	203	201	1	108	116
P0239A	204	201	1	115	116
P0240A	205	222	1	110	116
Zr A	206	200	2	91	116
O16 A	207	202	3	90	116
H2A A	208	230	3	114	116
OXYGEN	301	302	1	147	116
U235 A	302	210	1	106	116
U238 A	303	221	1	108	116
P0239A	304	221	1	115	116
P0240A	305	222	1	110	116
Zr A	306	200	2	91	116
OXYGEN	307	302	3	147	116
H2A B	308	401	3	159	116
FUEL G	901	0	1	0	116
CLAD G	902	0	2	0	116
MOD. G	903	0	3	0	116

NEW TEST TAP

NAME	NEW ID.	OLD ID.	REGION	OLD TAP LOC.	NO. ENERGY POINTS
A-LAST	0	0	0	0	0

10N XPT TAPST

PROGR= TERREST (ALL) (ALL) (ALL) = 11/10/10

*** ADD TEST * 2.2 - /) PROP-002 (CPC P0240) ROD IN H2O * .99 LS. ***
LIGHT MODERATOR

TEMPERATURE 2.9300+02 E MAX 0.3300-01 H1 SCATTERER 208 BUCKLING -0.0000

ISOTOPE	NUMBER	DENSITY
O16 A	1	1.5461-02
O235 A	2	5.4561-05
O238 A	3	7.5233-03
P0239A	4	1.4157-04
P0240A	5	1.1734-05
ZR A	6	3.8626-03
O16 A	7	1.8173-02
H WA A	8	3.6346-02

MODERATOR	NUMBER	DENSITY
OXYGEN	301	.1546-01
O235 A	302	.5456-04
O238 A	303	.7523-02
P0239A	304	.1416-03
P0240A	305	.1173-04
ZR A	306	.3863-02
OXYGEN	307	.1817-01
H WA S	308	.3635-01

ELEMENT NUMBER 101 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
 ELEMENT NUMBER 103 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
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 ELEMENT NUMBER 107 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.
 ELEMENT NUMBER 108 IS NOT IN THE LIBRARY. ITS CROSS SECTION HAS BEEN SET EQUAL TO ZERO.

AVERAGE TRANSPORT
CROSS SECTION
2.1303+00
TOTAL FLUX
1.1771+00

DIFFUSION CONSTANT
J AVERAGE
1.9340-01
XI SIGMA S
1.7338+00

MACRO ABSORPTION
CROSS SECTION
1.6621-01
NU SIGMA F
2.7696-01

ELEMENT	ID NUMBER	MICRO CROSS SECTION
O18 A	1	1.2595-04
U235 A	2	4.1260+02
U238 A	3	1.7286+00
PO239A	4	8.2628+02
PO240A	5	1.9614+02
ZR A	6	1.3063-01
O18 A	7	1.8173-04
H A A	8	2.9991-01
U235 F	102	3.5233+02
PO239F	104	5.6431+02
PO240F	105	3.0782-02
O18 X	201	3.3342+00
U235 X	202	8.2609+00
U238 X	203	6.6831+00
PO239X	204	7.9305+00
PO240X	205	7.9305+00
ZR X	206	5.8804+00
O18 X	207	4.5290+00
H A X	208	3.5847+01
OXIGEN	301	3.7776-01
U235 X	302	7.0498-02
U238 X	303	5.6296-02
PO239X	304	6.6565-02
PO240X	305	6.6247-02
ZR X	306	1.2985-01
OXIGEN	307	5.1311-01
H A S	308	4.7261+01
FOEL G	901	8.2847-01
CLAD G	902	9.4033-01
FOEL C	903	1.1255+00

PHI(D)

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0.000000

1.562400-05

6.224896-05

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2.470313-04

3.844607-04

5.514341-04

7.475947-04

9.725887-04

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1.492240-03

1.797995-03

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3.354662-02

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PHI(E)

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2.470313-04

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7.475947-04

9.725887-04

1.226065-03

1.492241+00

1.634541+00

1.775547+00

1.915232+00

2.053558+00

2.190470+00

2.325689+00

2.459695+00

2.591794+00

2.721619+00

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2.977511+00

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5.846129+00

5.948049+00

6.048936+00

6.148830+00

6.247781+00

6.345830+00

6.442927+00

6.539122+00

6.634365+00

PHI(F)

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.6800	3.797025-02	1.746308-01	1.187490-01
.6900	3.717009-02	1.722032-01	1.188202-01

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